INDOOR AIR QUALITY ASSESSMENT

Department of Social Services
24 Farnsworth Street
Boston, Massachusetts 02210

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
November 2005

Background/Introduction

On June 30, 2005, the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at the Department of Social Services (DSS) located at 24 Farnsworth Street, Boston, Massachusetts. The request was prompted by symptoms (e.g., sinus infections, eye and respiratory irritation, headaches), as well as temperature/comfort complaints reported by occupants. The indoor air quality assessment was conducted by Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Vincent Laberinto, Project Manager, Executive Office of Health and Human Services, Office of Facilities Leasing and Planning, for portions of the assessment.

The DSS occupies the first through fifth floors of a six-story brick building that was built as a warehouse in the early 1900s. The building reportedly underwent renovations in the early 1990s, prior to occupation by DSS. Windows are not openable in the building.

Methods

MDPH staff conducted air tests for carbon dioxide, temperature and relative humidity with the TSI, Q-Trak, IAQ Monitor, Model 8551. Moisture content of water-damaged ceiling tiles in the Adoption Subsidy Unit was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe. MDPH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The DSS has an employee population of approximately 500 and can be visited by up to 100 individuals daily. The tests were taken during normal operations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in fifty-five of seventy-two areas the day of the assessment, indicating poor air exchange in the majority of areas surveyed. Ventilation is provided by a heating, ventilating and air conditioning (HVAC) system, which consists of rooftop air handling units (AHUs) ducted to ceiling-mounted supply and return vents (Pictures 1 through 4). This system was operating throughout the building during the assessment. However, it is important to note that the HVAC system limits outside air intake on hot, humid days to maintain cooling (as was the case during this assessment), (Picture 5). Limiting outside air intake can contribute to an increase in carbon dioxide levels.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room, while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994). The date of the last balancing was not available at the time of the assessment.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings ranged from 72° F to 76° F, which were within the MDPH recommended comfort guidelines the day of the assessment. The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Although temperatures were within the MDPH recommended comfort range on the day of the assessment, complaints of uneven heating and cooling were expressed by occupants in areas throughout the building. As a general rule, ductwork should be as airtight as possible. MDPH staff examined AHUs on the roof and found several breaches in the ductwork (Picture 6) where cold/conditioned air was escaping. These breaches can result in an unbalanced ventilation system, which can make it difficult to maintain temperature/comfort control. Extreme heat was reported in the IT/Help Desk area on the third floor. Occupants reported that radiant heat vents were blocked by building maintenance personnel in an attempt to reduce heat (Pictures 7 and 8).

The relative humidity measurements in the building ranged from 38 to 46 percent, which were within or very close to the lower end of the MDPH recommended comfort range the day of the assessment. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A few areas had water-damaged ceiling tiles (Picture 9). Water-damaged ceiling tiles can provide a source for mold and should be replaced after a moisture source or leak is discovered and repaired. Occupants reported chronic roof leaks in the Adoption Subsidy Unit (ASU) on the fourth floor, which is located under a concrete block deck (Picture 10). Although the roof is equipped with drains (Picture 11), it appears that water may accumulate due to the presence of heavy moss growth between concrete blocks (Picture 12).

In order for building materials to support mold growth, a source of moisture is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. Building materials with increased moisture content over normal concentrations may indicate the possible presence of mold growth. Identification of the location of materials with increased moisture levels can also provide clues concerning the source of water supporting mold growth.

In an effort to ascertain moisture content of water-damaged ceiling tiles in the ASU, samples were taken in areas where water damage was present. A number of non-affected areas were measured for comparison. As previously mentioned, moisture content was measured with a Delmhorst Moisture Detector equipped with a Delmhorst Standard Probe. The Delmhorst probe is equipped with three lights that function as visual aids that indicate moisture level. Readings that activate the green light indicate a sufficiently dry or low moisture level, those that activate the yellow light indicate borderline conditions and those that activate the red light indicate elevated moisture content. No elevated moisture readings were measured during the assessment (Table 1). In addition, a thorough visual examination of water-damaged materials was conducted. Although, signs of water damage were apparent, no visible mold growth or associated odors were observed and/or detected during the assessment.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Several areas contained a number of plants. Plants, soil and drip pans can serve as sources of mold growth, and thus should be properly maintained. Plants should have drip pans to prevent wetting and subsequent mold colonization of window frames. Plants should also be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold.

Other Concerns

Several other conditions that can potentially affect indoor air quality were identified. A number of areas contained photocopiers, volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. VOCs are materials which evaporate readily and can be irritating to eyes, nose and throat. Ozone is a respiratory irritant (Schmidt Etkin, 1992). Responsible parties should ensure local exhaust ventilation is operating near photocopiers to remove/reduce excess heat and odors.

A number of supply and return/exhaust vents had accumulated dust (Picture 13). If exhaust vents are not functioning, backdrafting can occur, which can aerosolize dust particles. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation. Dust can be irritating to eyes, nose and respiratory tract.

Finally, of note was the amount of materials stored in cubicles, open areas and inside offices (Picture 14). In areas throughout the building, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Repair breaches in rooftop ductwork to prevent loss of conditioned air.
2. Consult a ventilation engineer concerning re-balancing of the ventilation systems. The Ventilation industrial standards recommend that mechanical ventilation systems be balanced every five years (SMACNA, 1994).
3. Encourage DSS staff to report any complaints concerning temperature control/preventive maintenance issues to the facilities department in order to help

HVAC engineer make adjustments/repairs to the system for thermal comfort. Particular attention should be made to reducing heat in the IT/Help Desk area on the third floor.

4. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g. throat and sinus irritations).
5. Replace water-damaged ceiling tiles. Examine the non-porous surface beneath the removed ceiling tiles and disinfect with an appropriate antimicrobial. Appropriate measures should also be taken to minimize the aerosolization of particulates from tile removal/replacement.
6. Change filters for HVAC equipment as per the manufacturer's instructions or more frequently if needed. Examine HVAC equipment periodically for maintenance and function.
7. Consider consult with an architect, masonry firm or general contractor regarding the integrity of the building envelope, primarily concerning water penetration through the fifth floor roof deck. Ensure proper drainage, make repairs as needed.
8. Relocate or consider reducing the amount of materials stored in cubicles, office and common areas to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.

9. Clean supply and return/exhaust vents periodically of accumulated dust.
10. Refer to resource manuals and other related indoor air quality documents for additional building-wide evaluations and advice on maintaining public buildings. These materials are located on the MDPH's website: http://mass.gov/dph/indoor_air.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

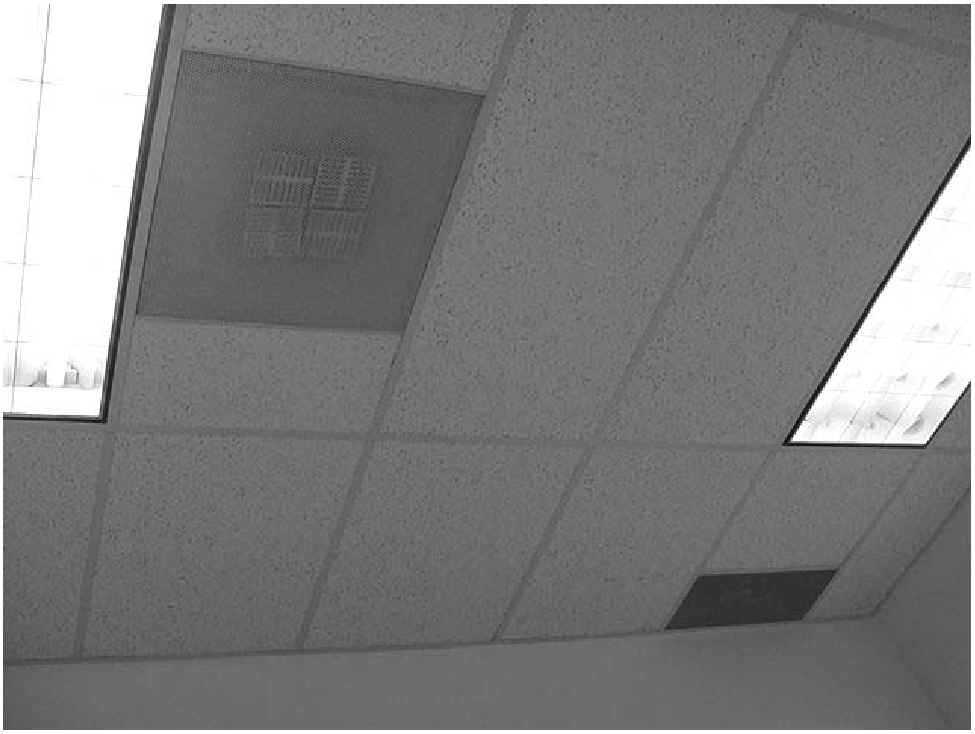
SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2001. Mold Remediation in Schools and Commercial Buildings. US Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Washington, D.C. EPA 402-K-01-001. March 2001.

Picture 1

Rooftop Air Handling Unit

Picture 2



Ceiling-Mounted Supply and Return Vents

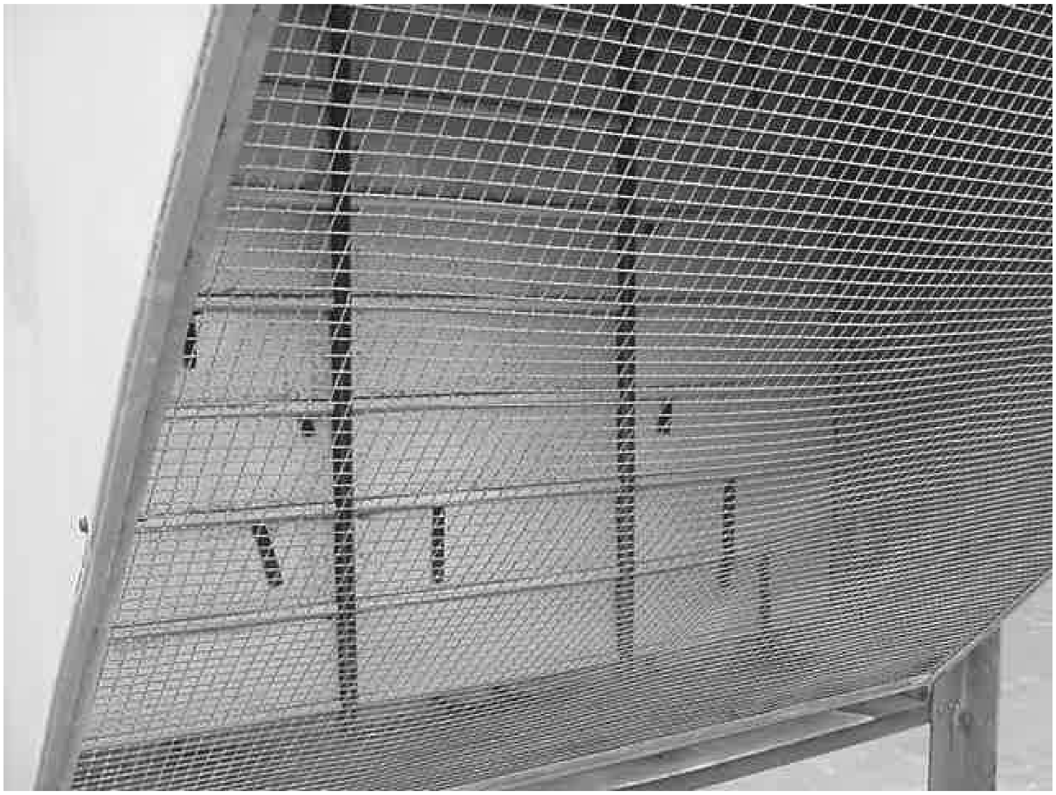
Picture 3

Slotted Ceiling-Mounted Supply Vent, Note Beer Bottle in Vent

Picture 4

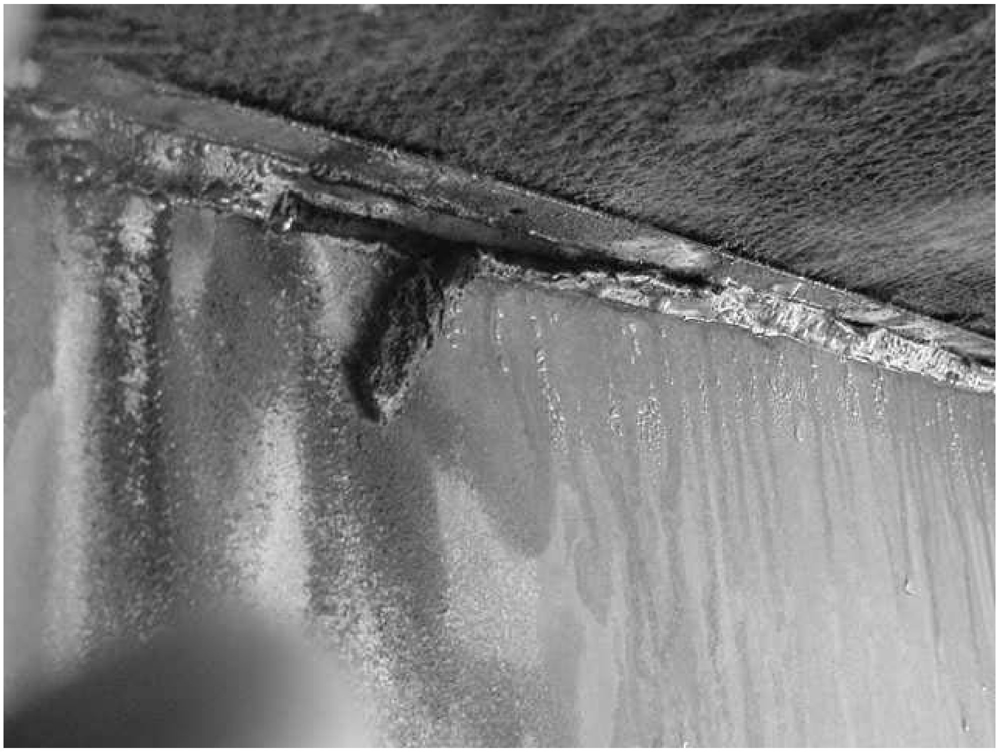
Ceiling-Mounted Supply Vent

Picture 5



Rooftop AHU Supply Intake Louvers Shut, Limiting Airflow

Picture 6



Open Seam Joints in Ductwork on Roof Where Conditioned Air was Escaping

Picture 7

Blocked Perimeter Radiator Vents in

Picture 8

Close-up of Blocked Radiant Heat Vents

Picture 9

Water Damaged Ceiling Tiles, 4th Floor Adoption Subsidy Unit

Picture 10

Concrete Block Deck over 4th Floor, Accessible from Cafeteria on 5th Floor

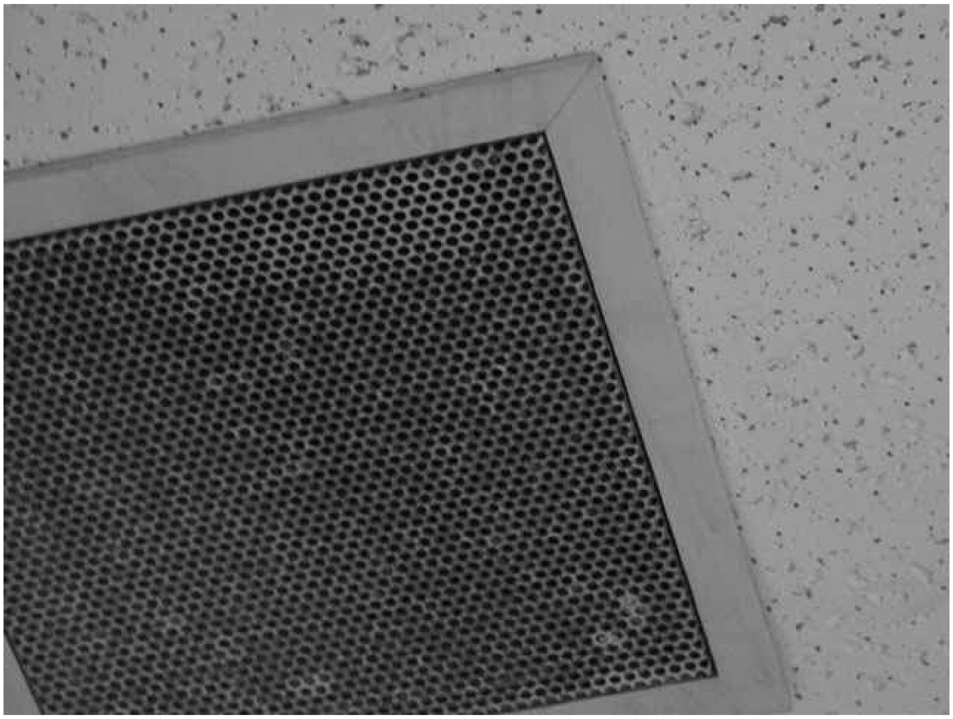
Picture 11

Roof Drain on 5th Floor Concrete Block Deck

Picture 12

Moss/Plant Growth between Concrete Blocks 5th Floor Deck

Picture 13



Dust Accumulation on Ceiling-Mounted Return Vent

Picture 14

Accumulated Items in Open Area

TABLE 1

Indoor Air Test Results – DSS Offices, 24 Farnsworth St., Boston, MA June 30, 2005

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	397	80	85					Warm, sunny, humid
Roof								Loss of airflow from breaches in AHU ductwork
512	874	75	39	2	N	Y	Y	DEB
516	881	75	41	1	N	Y	Y	Temperature control complaints (heat), little airflow detected from supply vent
Finnegan	916	74	42	3	N	Y	Y	
Murphy	939	74	42	1	N	Y	Y	4 CT
545	899	73	41	0	N	Y	Y	
521	905	74	41	0	N	Y	Y	DO
523 Law Library	859	73	41	0	N	Y	Y	

- **ppm = parts per million parts of air**
- **CT = water damaged ceiling tile, DO = door open**
- **DEB = dry erase board, PF = personal fan**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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						Supply	Exhaust	
Stiles	897	74	41	2	N	Y	Y	
520	910	75	43	2	N	Y	Y	3 CT
Break Room	622	73	42	0	N	Y	Y	DO
Scholefield	948	76	43	2	N	Y	Y	DO
Special Invest Unit	898	75	41	1	N	Y	Y	1 CT, DO
539	887	74	40	1	N	Y	Y	
509	916	75	40	1	N	Y	Y	DO, PF
Wentworth	826	75	39	0	N	Y	Y	DO, plant
403	855	76	41	2	N	Y	Y	1 CT, temperature control complaints

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						Supply	Exhaust	
Adoption Subsidy Unit	1001	76	40	3	N	Y	Y	Chronic roof leaks (below 5th floor deck), 4 CT low moisture content
Adoption Contract Unit	1008	75	42	4	N	Y	Y	DO
Banks	888	74	40	0	N	Y	Y	
413	840	73	39	0	N	Y	Y	DO
415	828	73	38	0	N	Y	Y	DO
Foster Care Review	820	74	39	4	N	Y	Y	2 CT
417	872	75	39	0	N	Y	Y	
Murray	875	75	40	1	N	Y	Y	DO, heat control issues
Foster Care Review Director	1100	75	42	4	N	Y	Y	

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420	872	75	39	2	N	Y	Y	
424	879	74	40	3	N	Y	Y	
Domestic Violence Unit	885	74	40	3	N	Y	Y	Plants
426	915	74	42	0	N	Y	Y	
429	991	76	41	1	N	Y	Y	Heat issues, poor air flow complaints, DO
433	961	75	43	1	N	Y	Y	Temperature control issues (heat), DO
431	1014	75	43	1	N	Y	Y	
315	973	74	41	3	N	Y	Y	DEB, DO
316	910	74	41	1	N	Y	Y	DO

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Wilfand	991	73	41	1	N	Y	Y	
319	989	73	42	1	N	Y	Y	
320	948	74	41	2	N	Y	Y	
322	915	74	42	0	N	Y	Y	
323	910	74	41	2	N	Y	Y	
Help Desk	725	72	46	6	N	Y	Y	Rattling noise from vents, chronic temperature control issues (heat), rubber mats blocking radiant heat vents to reduce temp
IT Financial	983	75	41	5	N	Y	Y	
307	981	75	41	3	N	Y	Y	DO
310	1160	74	39	5	N	Y	Y	DO, headaches

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279	941	74	39	2	N	Y	Y	
313	891	74	39	0	N	Y	Y	
Woldeguiorguis	900	75	45	2	N	Y	Y	Little air movement detected from supply vent, DO, dusty vents
Deveney	897	75	41	2	N	Y	Y	DO
CORI	744	74	40	4	N	Y	Y	
CORI (Keegan)	779	72	39	2	N	Y	Y	Beer bottle in supply vent (ceiling), plants
MacCormack	753	73	41	3	N	Y	Y	
Destefano	744	73	40	0	N	Y	Y	
209	781	73	41	1	N	Y	Y	DO

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Kelly	750	73	40	1	N	Y	Y	PF
File Room	753	73	40	2	N	Y	Y	3 CT, photo copier
Affirmative Action	740	73	41	1	N	Y	Y	Temp control issues, DO
Maciolek	958	74	43	2	N	Y	Y	DO
Ashby	820	74	44	2	N	Y	Y	
Staffing Analysis	820	74	45	2	N	Y	Y	Sneezing, nasal irritation, runny nose
Morey	806	74	45	3	N	Y	Y	
Iovanni	964	74	45	2	N	Y	Y	
Driscoll	846	75	45	2	N	Y	Y	

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Bruno	822	74	44	2	N	Y	Y	
215	812	73	43	1	N	Y	Y	
Commissioners Office	761	73	41	2	N	Y	Y	DO
Reception	811	73	45	2	N	Y	Y	
Freer	804	74	46	1	N	Y	Y	DO
Training Room A	716	72	45	0	N	Y	Y	DEB
Library	729	72	45	0	N	Y	Y	1 CT
Training	763	74	45	2	N	Y	Y	DO
Rheaume	767	74	44	2	N	Y	Y	

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108	742	74	43	1	N	Y	Y	DO
110	724	74	41	4	N	Y	Y	DO

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